



U.S. DEPARTMENT OF  
**ENERGY**

**Nuclear Energy**

---

# **Clean Energy Program Outlook Nuclear Energy Perspective**

## **Pathways to Decarbonization International Workshop**

**Suibel Schuppner**

**Office of Nuclear Energy  
U.S. Department of Energy**

June 9, 2016



- 
- **Nuclear's role in the U.S. clean energy portfolio**
  - **Transition to the nuclear fleet of the future**
  - **Nuclear technology innovation**
  - **Nuclear-Renewable Hybrid Energy Systems Program**
  - **Summary**



# Policy Drivers that support the Expansion of Clean Energy

## ■ Executive Order #13693 - March 19, 2015

- Reduce Federal facility greenhouse gas emissions 40% by 2025
- Defines "clean energy" to include alternative energy
  - Definition of "alternative energy" includes "small modular nuclear reactor technologies"



## ■ Clean Power Plan – August 3, 2015

- Sets CO<sub>2</sub> emissions performance goals for every State in U.S.
- Provides flexibility to States to choose how to meet carbon standards
  - Include renewables, energy efficiency, natural gas, nuclear and carbon capture and storage

## ■ UN Framework Convention on Climate Change (COP21) – December 12, 2015

- International agreement to limit average temperature rise to <2°C
- Reaffirmed U.S. commitment to carbon reduction goals



# Nuclear Power: A Sustainable Clean Power Source

*"To meet our emissions reduction targets and avoid the worst effects of climate change, we need to dramatically reduce power sector emissions. Switching from coal to natural gas is already reducing the U.S. carbon footprint, but it's not enough to get the deep CO<sub>2</sub> cuts envisioned in the President's Climate Action Plan. Reducing emissions by 80% will likely require the complete decarbonization of the power sector....*



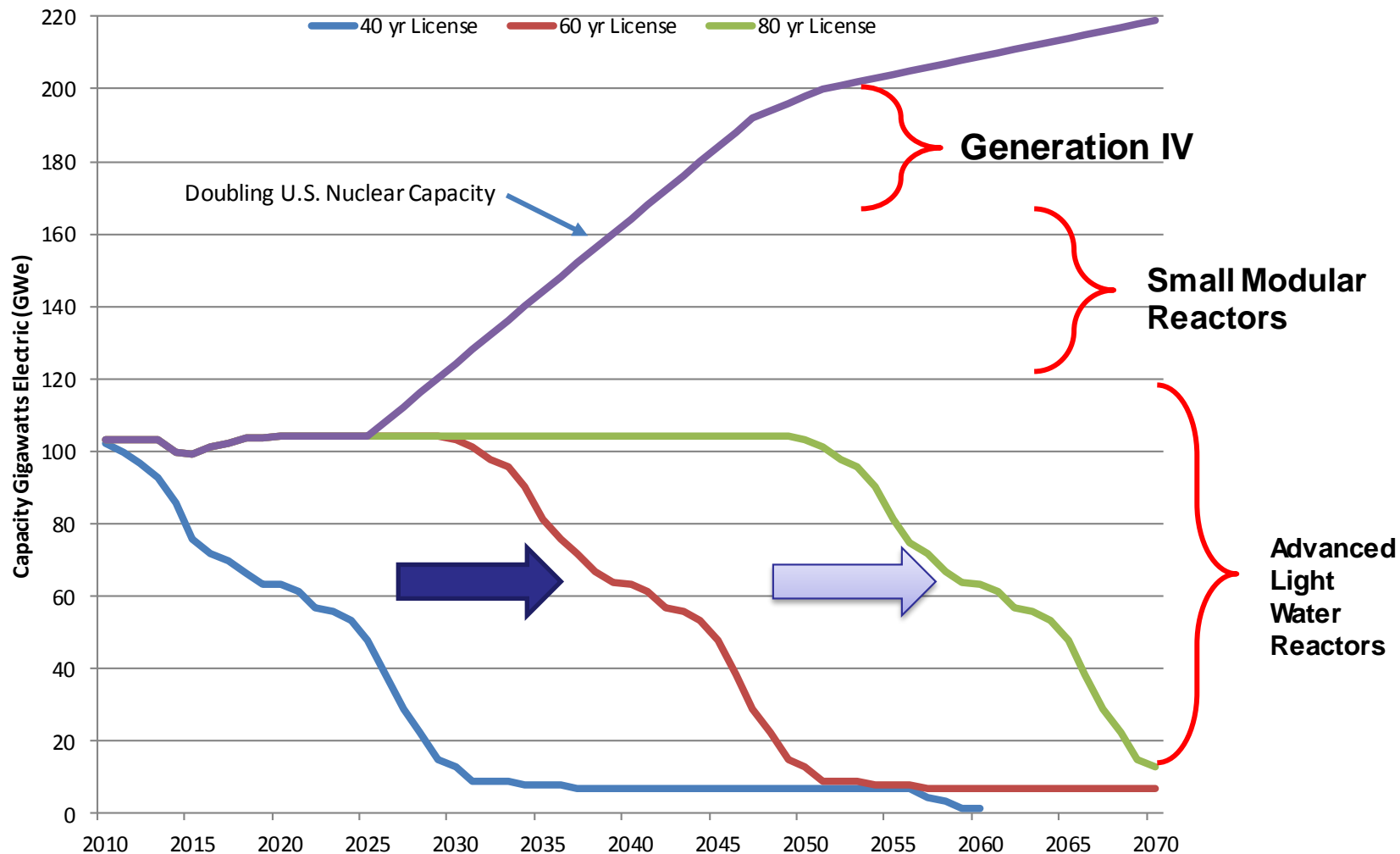
Secretary Moniz  
COP21, Paris 2015

***We know nuclear can provide 24-hour baseload power, because it already does. Worldwide, nuclear power produces more energy than hydro, solar, wind, and geothermal power combined.***

***The bottom line is that to achieve the pace and scale of worldwide carbon reductions needed to avoid climate change, nuclear must play a role."***



# Nuclear Power Capacity needed to meet U.S. Clean Power Goals





# Challenges to Innovation in Nuclear

- Development and deployment timeframe is long
- Costs and investment risks are high
- Highly regulated industry with significant public interest
- Plant owners are somewhat “conservative” with respect to emerging/innovative technologies
- Overcoming government bureaucracy





# Small Modular Reactor Licensing Technical Support Program

- **To promote accelerated deployment of U.S. SMRs**
- **Provides cost-share to reduce risks for initial movers in the SMR industry as they pursue:**
  - Design: Partnered with mPower and NuScale to:
    - Advance design
    - Develop SMR Design Certification Application and submit for regulatory review
  - Siting:
    - Tennessee Valley Authority's Early Site Permit and Combined Operating License (COL) Applications for an SMR on their Clinch River Site
    - Utah Associated Municipal Power Systems' COL Application for NuScale SMR on Idaho National Laboratory
- **Next Steps: NE will soon seek input from industry to inform potential follow-on program focusing on commercialization of SMRs**
  - Advanced design / COL Applications / Incentives / Manufacturing / Additional features







# Growing National Interest in Advanced Reactors

- **There is a growing interest in the development and deployment of advanced (non-light water) nuclear reactor technologies**
  - According to Third Way, there are 48 companies in North America, backed by >\$1.6 billion in private capital developing plans for advanced nuclear reactors (Jan 2016 Summit and Showcase)
  - The Administration recently emphasized support for nuclear as an essential part of the All of the Above clean energy strategy (Nov 2015 White House Convening)
- **DOE-NE is conducting an Advanced Test/Demonstration Reactor Study as directed by Congress in the FY2015 Omnibus Spending Bill**
- **Secretary of Energy Advisory Board Task Force on the Future of Nuclear Power is examining the possibility of a major new deployment of nuclear power, to include advanced reactors, in the 2030-2050 time period**
- **NRC-DOE Joint Workshops on Advanced Non-Light Water Reactors**





# Vision & Strategy for Advanced Reactors

## VISION

By 2050, advanced reactors will provide a significant and growing component of the nuclear energy mix both domestically and globally, due to their advantages in terms of improved safety, cost, performance, sustainability, and reduced proliferation risks.

## GOAL

By the early 2030s, at least two non-light water advanced reactor concepts would have reached technical maturity, demonstrated safety and economic benefits, and completed licensing reviews by the U.S. Nuclear Regulatory Commission (NRC) sufficient to allow construction to go forward.



# Gateway for Accelerated Innovation in Nuclear

## What are the Problems/Issues?

- Time to market for nuclear technology is too long.
- Facilities needed to conduct the necessary RD&D activities are very expensive to develop and maintain.
- Capabilities (e.g., facilities, expertise, materials, and data) at government sites have not been easily accessible by the entities trying to commercialize innovative systems and components.
- Technology readiness levels vary – requiring differing research and funding opportunities.
- Many technology developers require assistance working through the regulatory process for new nuclear technologies.

## What do we need to do?

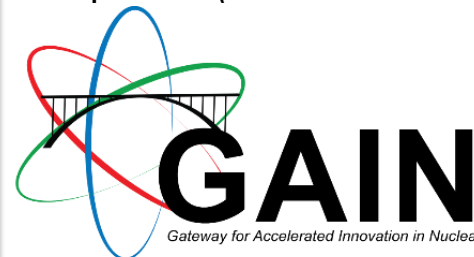
- Provide nuclear innovators and investors with a single point of easy access to the broad range of capabilities – people, facilities, materials, and data – across the DOE complex.
- Provide focused research opportunities and dedicated industry engagement, ensuring that DOE-sponsored activities are impactful to stakeholders working to realize the full potential of nuclear.
- Expand upon DOE's work with the Nuclear Regulatory Commission (NRC) to assist technology developers through the regulatory process.

## What is the DOE initiative?

- Public-private partnership headquartered at INL
- Dedicated to **accelerated commercial readiness of innovative technologies**

### **Government Assets:**

- Tens of \$B in DOE and partner assets (*experimental and computational*)
- Multi-\$B in yearly investments for R&D and infrastructure
- \$12.5 B in loan guarantees
- Small Business vouchers
- Expertise (*thousands of FTE/yr.*)



# Nuclear-Renewable Hybrid Energy Systems (N-R HES) Collaboration

**Goal:** Develop a joint integrated strategy that builds upon the Office of Nuclear Energy (NE) and the Office of Energy Efficiency and Renewable Energy (EERE) expertise to:

- Study potential pathways that could produce economy-wide decarbonization, and
- Identify new generation and advanced grid technologies to help the U.S. achieve economy-wide GHG emissions reductions by 2050.

## Objectives:

- Assess the viability, value proposition, and competitiveness of integrated, low-carbon energy systems that are specific to U.S. regional resources and energy needs;
- Define potential crosscutting RD&D paths on future electrical grid and industrial energy networks (integrated systems) and analyze specific scenarios that could result in economy-wide deep decarbonization; and
- Pinpoint critical renewable and nuclear technology innovation requirements that can enable the deployment and deep decarbonization potential of integrated low-carbon energy systems.



# Nuclear-Renewable Hybrid Energy Systems (N-R HES) Collaboration

**Plan:** Conduct two joint analysis strategies that incorporate state-of-the-art nuclear and renewable technology assumptions, systems modeling, and simulation

## **NE will lead the joint effort to:**

- ❑ Identify and model regional opportunities for co-managed nuclear and renewable hybrid systems, and investigate how to incorporate these innovative energy systems into the grid
- ❑ Perform a survey of process heat applications that could utilize thermal energy available in co-managed nuclear-renewable hybrid energy systems

## **EERE will lead the joint effort to:**

- ❑ Analyze potential deep decarbonization scenarios that would assess the extent to which mass electrification of the transportation, buildings, and industrial sectors, coupled with low-carbon generation and advanced grid technologies, could help the U.S. achieve economy-wide GHG emissions reductions along the lines of 80% relative to 2005 levels by 2050
- ❑ Examine potential options that could decarbonize sectors of the economy where electrification would be difficult, including providing thermal energy and/or hydrogen to those end uses, potentially using hybrid energy and nuclear systems
- ❑ Improve existing analytical tools to better understand the impact of high variable penetration on the grid



# Nuclear-Renewable Hybrid Energy Systems (N-R HES) NE's Accomplishments



- Initiated dynamic analysis for regional Integrated Energy System Case Studies
- Developed an Integrated Energy Systems Modeling, Simulation and Control Gap Analysis Report
- Conducted a study and issued a report on the major challenges and technology needs to enabling a zero-carbon nuclear-renewable grid
- Completed N-R HES Program Plan in March 2016
- Issue status report on Advanced Modeling & Simulation Tool Development by September 2016
- Complete Industrial Thermal Energy User Analysis by September 2016

- Complete Phase I Feasibility Assessment and Options Study
- Assess results for initial “Go/No-Go” Decision Point:
  - Can a reasonable path forward be identified for selected configurations?
  - Is there good potential for industry investment?
- Refine Technical Performance and Economic Analysis Models
- Initiate Industry engagement to support concept development
- Begin to establish infrastructure to support nonnuclear test bed for integrated systems for component and subsystem characterization and model validation



- Nuclear energy is an essential element of the future clean energy mix.
- There is a strong sense of urgency to develop and deploy innovative technologies to address climate change
- Government leadership and effective engagement with the private sector is critically needed
- Seek to double investments in clean energy innovation
  - Mission Innovation
  - Breakthrough Energy Coalition



United Nations, April 25, 2016